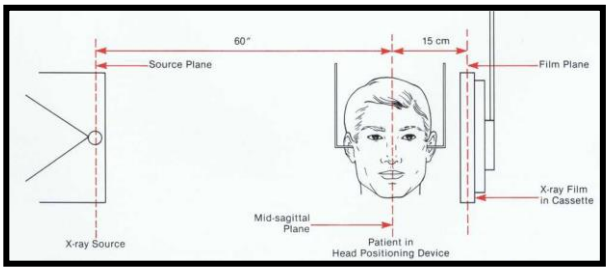
Cephalometric Analysis
Cephalometric landmarks, planes & angles

Cephalic = head
metric = measurement
Cephalometric radiography: - is a standardized method of production of skull radiographs, which are useful in making measurements of the cranium and the orofacial complex.
Cephalometry: - is the analysis & interpretation of standardized radiographs of the facial bones so, cephalometric radiography is a specialized radiographic technique concerned with imaging the craniofacial region in a standardized and reproducible manner.
There are two main types of cephalometric radiography:
1. True lateral cephalometric: it is commonly used for orthodontic analyses.
2. Frontal cephalometric (posteroanterior): usually used to assess the symmetry of the face.
In practice, Cephalometrics has come to be associated with a true lateral view. An anteroposterior radiograph can also be taken in the cephalostat, but this view is usually employed in cases with a skeletal asymmetry.
A cephalometric analysis identifies defined anatomical landmarks on the film and measures the angular and linear relationships between them.
This numerical assessment can provide detailed information on the relationship of skeletal, dental, and soft tissue elements within the craniofacial region.

The cephalometric X-ray is a two-dimensional figure i.e. it gives us the picture of 2 planes. The lateral one, which is commonly used, clears the anteroposterior and vertical planes.
This is achieved by using a cephalostat, which holds the mid-sagittal plane of the head at a fixed distance from both the X-ray source and film, keeping the magnification constant for every radiograph.

For a cephalometric lateral skull radiograph, the mid sagittal plane is oriented perpendicular to the X-ray beam and parallel to the film, whilst a posteroanterior film requires the mid-sagittal plane to be parallel to the X-ray beam and perpendicular to the film. Subjects are usually oriented in a natural head posture or with the Frankfort plan horizontal and teeth in centric position.

In the lateral cephalometric X-ray an actual size of the head is produced with the help of special machine in which there is an equal and standardized distance from the tube – object – film as seen in this diagram.

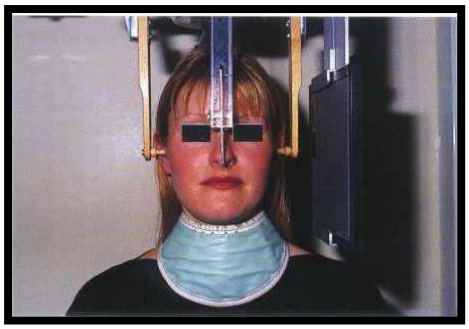


Components of X-ray machine: -

In order to be able to compare the cephalometrics radiographs of one patient taken on different occasions, or those of different individuals, some standardization is necessary.

A cephalometric apparatus consists of an X-ray source, a cephalostat or head holding device, and a cassette holder/sensor. They should be at a fixed distance to each other to achieve the standardization which is necessary in order to be able to compare the cephalometric radiographs of one patient taken on different locations, or those of different individuals.

1-The Cephalostat: holds the head in a predetermined position. The cephalostat is an apparatus that contain 3 adjusted rods that can fix the head, the two lateral rods are called the ***ear rods*** (ear posts designed to fit into the patient's external auditory meatus) to prevent movement of the head in horizontal plane and so that the central beam of the machine is directed toward the ear rods. and the frontal one is applied on the N point.



The position of the head in the vertical axis is standardized by ensuring that the patient Frankfort plane is horizontal.

This can be done manually by positioning the subject with the aid of the nasal rod or, alternatively, by placing a mirror some distance away leveled with the patient's head and asking him to look into his own eyes. This is termed the ***natural head position*****.** The patient should be in centric occlusion and the distance from the X-ray source to the subjects' midsagittal plane is kept at 5 feet. The distance from the midsagittal plane to the cassette/sensor can vary in different machines (0.5-1 foot), but must be the same for each patient every time. Some magnification usually of the order of 7-8% is inevitable with a lateral cephalometric film.

To give a better definition of the soft tissue outline of the face, either thin layer of barium paste can be placed down the central axis of the face or an aluminum wedge positioned so as to attenuate the beam in that area.

2-The X-ray machine which is at a fixed distance from a set of ear posts. Thus, the central beam of the machine is directed towards the ear post, which also serves to stabilize the patient's head. The position of the head in the vertical axis is standardized by ensuring that the patient's Frankfort plane is horizontal.

The X-ray source is at a fixed distance from the cephalostat and film. In addition, the beam is collimated to reduce irradiation by exposing only those structures of interest to the orthodontist, the cranial base, facial skeleton and jaws.

3-Film cassette.

Attempts to standardize the distances from the tube to the patient (usually between 5 & 6 feet) & from the patient to the film (1 foot). The distance from tube to object and the film is near to the head as much as possible in order to minimize magnification.

Indications for Cephalometric Evaluation:

An increasing awareness of the risks associated with x-ray has led clinicians to re-evaluate the indications for taking a cephalometric radiograph. The following are considered valid.

1) An aid to diagnosis, it is possible to carry out successful orthodontic treatment without taking a cephalometric radiograph, particularly in Class I malocclusion. However, cephalometric analysis may provide useful information for assessing the etiology of malocclusion and for planning treatment, **especially the differentiation between skeletal and dental malrelationship**. The benefit to the patient in terms of the additional information gained must be weighed against the radiation dose. Therefore, a lateral cephalometric radiograph is best limited to patient with a skeletal discrepancy &/or where anteroposterior movement of the incisors is planned.

Information on the relationship of the jaws and dentition in both the anteroposterior and vertical planes of space and their relationship with the soft tissue profile is an important factor in orthodontic diagnosis and treatment planning, Cephalometrics help in developing a clear treatment plan. A detailed analysis of the dentoskeletal relationship aids in treatment planning and determining the appropriate treatment approach.

A cephalometric radiograph can also provide information regarding the size and morphology of the airway.

In a small proportion of patients, it may be helpful to monitor growth to aid the planning and timing of treatment by taking serial cephalometric radiographs and whether the case can be treated by growth modification or orthognathic surgery. Although again, the dosage to the patient must be justifiable. In addition, a lateral view is often helpful in the accurate localization of unerupted displaced teeth and other pathology.

2) Study of craniofacial growth, serial cephalometric studies have helped in providing information regarding: -

a. the various growth patterns.
b. the formation of standards, against which other cephalograms can be compared.
c. predication of future growth.
d. prediction the consequences of particular treatment plan.

3) A pretreatment radiograph A lateral cephalometric radiograph is useful in providing a baseline record prior to the placement of appliance, particularly where growth modification or where movement of the upper & lower incisors is planned.

4) Monitoring the progress of treatment in the management of sever malocclusion, where tooth movement is occurring in all 3 planes of space (for ex. Treatments involving functional appliances, or U&L fixed appliances), it may be helpful to take a lateral cephalometric radiograph during treatment to monitor incisor inclinations and anchorage requirements. A cephalometric radiograph taken during orthodontic therapy can provide information on how treatment is progressing. This allows the orthodontist to evaluate skeletal, dental and soft tissue relationships and assess what further changes will be required to produce an aesthetic and stable result.

A cephalometric lateral skull radiograph is also essential prior to planning surgical movement of the jaws. It is common to take a lateral Cephalometric radiograph during treatment to monitor *anchorage requirement & incisor inclinations***.**

5) End of Orthodontic Treatment: For patients with severe malocclusions, a lateral cephalometric radiograph may be taken near the end of active treatment to check all treatment objectives have been met and to aid planning of retention.

Study of relapse and stability of treatment, cephalometric X-ray helps in identifying causes of orthodontic relapse and stability of treated malocclusions.it helps in establishing positions of individual teeth within the maxilla or the mandible, which can be considered to be relatively stable.

Post-treatment lateral cephalometric radiographs are usually restricted to patients where there is uncertainty around the stability of the outcome as a result of the treatment methods used, or a concern around future unfavorable growth.

6) Research purposes, a greater deal of information has been obtained about growth & development by longitudinal studies which involved taking serial cephalometric radiographs. From birth to the late teens or beyond. The data provided by previous investigations are still used for reference purposes, it is no longer ethically possible to repeat this type of study due to the risks associated with ionizing radiation. However, views taken routinely during the course of orthodontic diagnosis and treatment for clinical care may be used to study the effects of growth and treatment if the necessary consent and ethical approval are obtained.

Tracing a lateral skull cephalometric radiograph

Hand tracing: acetate tracing sheet should be secured onto the film with masking tape. The tracing should be carried out in a darkened room on a light viewing box, and a sharp pencil used for the tracing. It should begin with a general inspection of the cephalogram and then locate and identify standard landmarks. This is followed by tracing the anatomic structures in a logical sequence, and finally constructing derived landmarks and lines.

A lateral skull radiograph should be hand–traced in a darkened room with suitable back illumination using a hard pencil and high-quality tracing paper attached the radiograph. The peripheral regions of the radiograph should be masked to highlight the cranial base and facial complex. Bilateral structures should be traced independently and then averaged. Alternatively, the landmarks and tracing can be digitized directly into a computer using specialized software, which will instantly produce an analysis.

Digital radiographs:

Conventionally, following the exposure of the X-ray beam onto the radiographic film, it is processed to give an individual radiograph. With digital radiographs the image is stored electronically and viewed directly on a computer screen. This approach has the advantage that processing faults are eliminated and the storage and transfer of images is facilitated.

Tracing Technique and Digitizing

Before starting a tracing, it is important to examine the radiograph for any abnormalities or pathology. For example, a pituitary tumor could result in an increase in the size of the Sella turcica.

Digitization: for digital radiographs the points can be entered directly by a mouse click. Specialized software can then be employed to utilize the information entered to produce a tracing and/or the analysis of choice.

Note: For landmarks which are bilateral, an average of the two should be taken unless they are directly superimposed.

Cephalometric Analysis: General Points

There are different cephalometric analyses, but no single method is sufficient for all purposes and that all have their drawbacks.

Cephalometric analysis is often based upon comparing the values obtained for certain measurements for a particular individual (or group of individuals) with the average values for their population (e.g. Caucasians). Cephalometric analysis is also of value in identifying the component parts of a malocclusion and probable etiological factors - it is useful when a tracing is finished to reflect why that individual has that particular malocclusion. However, it is important not to fall into the trap of giving more credence to cephalometric analysis than it actually merits, it should always be remembered that it is an adjunctive tool to clinical diagnosis, and differences of cephalometric values from the average are not in themselves an indication for treatment, particularly as variations from normal in a specific value may be compensated for elsewhere in the facial skeleton or cranial base. In addition, cephalometric errors can occur owing to incorrect positioning of the patient and incorrect identification of landmarks.

Cephalometric land marks:

Readily recognizable points on a cephalometric radiograph or tracing, representing certain hard or soft tissue anatomical structures (anatomical landmarks) or intersections of lines (constructed landmarks).

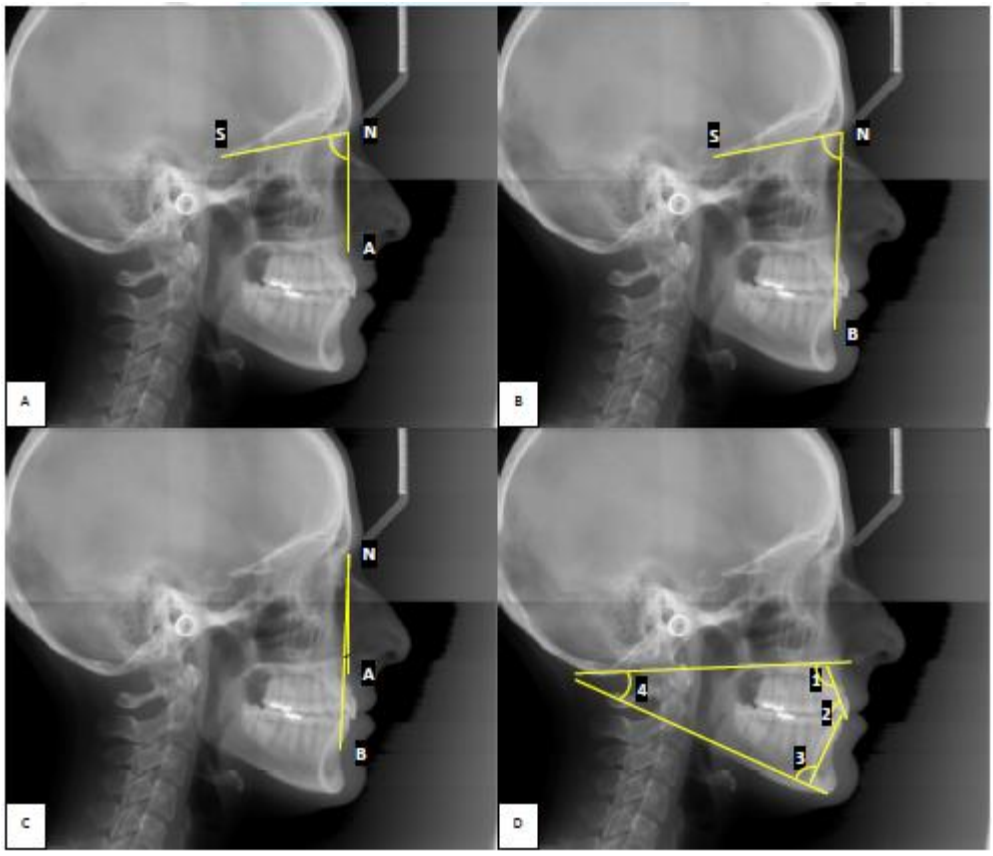
Landmarks are used as reference points for the construction of various cephalometric lines or planes & for subsequent numerical determination of cephalometric measurements.

In the definition of the specific landmark convention is used "midsagittal" identifies landmarks lying on the midsagittal plane, "unilateral" identifies landmarks corresponding to unilateral structures&"bilateral" applies to landmarks corresponding to bilateral structures.

A lateral cephalometric radiograph is a slightly magnified, two-dimensional representation of three-dimensional object (the patient). For this reason, angular measurements are generally to be preferred to linear measurements, as the element of magnification is less important.

Cephalometric Norms for Caucasians (Eastman Standard)

Measurements	Value
SNA	**81º ± 3º**
SNB	**78º ± 3º**
ANB	**3º ± 2º**
U1/Maxillary Plane	**109º ± 6º**
L1/Mandibular Plane	**93º ± 6º**
Inter-incisal angle	**135º ± 10º**
MMPA	**27º ± 4º**



A: SNA. B: SNB. C: ANB. D: (1) U1/Maxillary plane angle, (2) Inter-incisal angle, (3) L1/Mandibular plane angle, (4) Maxillary/Mandibular plane angle angle.

Commonly Used Cephalometric Points and Reference Lines

Points

Point A (A): the point of deepest concavity on the anterior profile of the maxilla. It is also called *subspinale*. This point is taken to represent the anterior limit of the maxilla. It is located on alveolar bone and is liable to change in position with tooth movement and growth.

Point B (B): the point of deepest concavity on the anterior surface of the mandible. It is also called *supramentale*. It is also located on alveolar bone and is liable to change in position with tooth movement and growth.

Anterior nasal spine (ANS): the tip of the anterior process of the maxilla, situated at the lower margin of the nasal aperture.

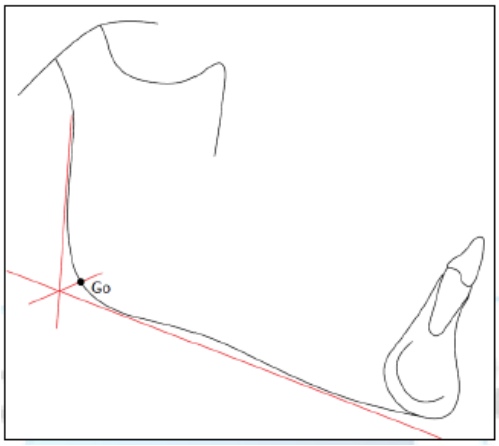
Posterior nasal spine (PNS): the tip of the posterior nasal spine of the maxilla. This point is often obscured by the developing third molars, but lies directly below the pterygomaxillary fissure.

Gonion (Go): the most posterior inferior point on the angle of the mandible. This point can be determined more accurately by bisecting the angle formed by the tangents from the posterior border of the ramus and the inferior border of the mandible.

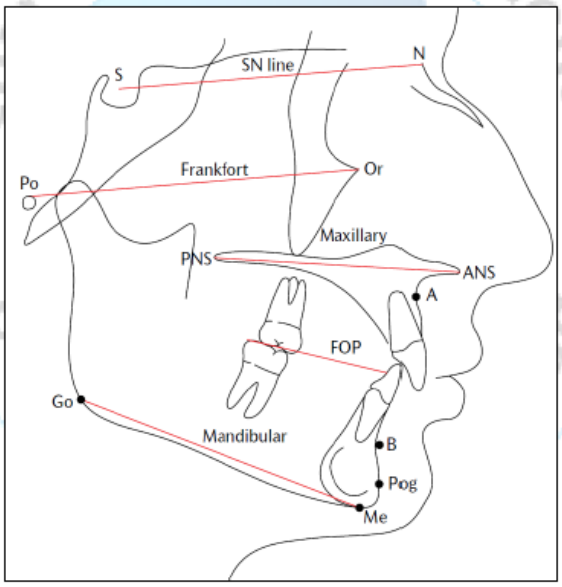
Menton (Me): the lowest point on the mandibular symphysis.

Pogonion (Pog): the most anterior point on the mandibular symphysis.

Nasion (N): the most anterior point on the frontonasal suture. If it is difficult to locate the nasion, the point of deepest concavity at the intersection of the frontal and nasal bones can be used instead.
Orbitale (Or): the most inferior anterior point on the margin of the orbit. It can be a little tricky to determine radiographically.
Porion (Po): the uppermost outermost point on the bony external auditory meatus. This landmark can be obscured by the ear rods of the cephalostat and some advocate tracing these instead (mechanical Porion).
Sella (S): the midpoint of the Sella turcica.
Articulare (Ar): the point of intersection of the outlines of the posterior border of the mandible & the inferior border of the temporal bone.
Basion (Ba): the lowest point on the anterior margin of the foramen magnum in the midline. The tip of the posterior cranial base.
Pterygomaxillary point (PTM): the lowest point of the outline of the pterygomaxillary fissure. a bilateral teardrop-shaped area of radiolucency, the anterior shadow of which is the posterior surfaces of the tuberosities of the maxilla.



CEPHALOMETRIC PLANES ((Horizontal reference planes)):



S-N plane: represents the anterior cranial base of the skull. The SN it is constructed by connecting the midpoint of Sella turcica and the Nasion
This reference plane is used principally: -
*When relating the jaws to the anterior cranial base; and
*When superimposing serial lateral skull radiographs.

Frankfort horizontal plane: line joins Orbitale & Porion. This plane is difficult to record accurately because of the problems inherent in determining Orbitale and Porion.
The Frankfort horizontal is one of the few reference planes that can be identified both ***clinically*** and on a ***radiograph***.

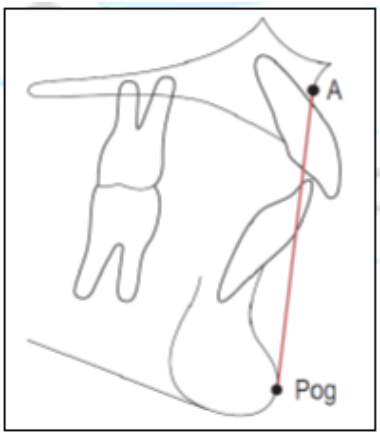
Maxillary Plane:(palatal plane) line joins ANS to PNS represents the level of maxilla could be parallel to Frankfort plane. Where it is difficult to determine ANS and PNS accurately, a line parallel to the nasal floor can be used instead.
It's useful for assessing:
*Vertical jaw relationship:
Maxilla to Frankfort plane;
Maxilla to SN plane;
Maxilla to mandible.
*Inclination of the upper incisors to the maxillary skeletal base.

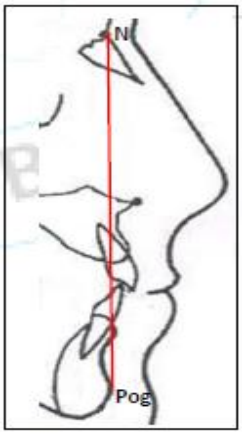
Mandibular Plane: line joins Me to Go represents the level of the lower border of the mandible.
It's useful for assessing:
*Vertical jaw relationship:
Mandible to Frankfort plane;
Mandible to SN plane;
Mandible to mandible.
*Inclination of the lower incisors to the mandibular skeletal base.

Functional occlusal plane (FOP): (functional OP, Anatomic OP)
A line bisects the incisor overbite (from the midpoint between the tips of upper &lower incisors to the anterior (occlusal) contact between upper 6 & lower 6 at centric occlusion.
The line drawn between the cusp tips of the permanent molars and premolars (or deciduous molars in mixed dentition).
Note: The horizontal reference lines used for growth pattern assessment.

Vertical Reference Lines

A-Pog Line: it is a line from point A to the Pogonion.
Facial Plane: it is a line from the Nasion to the Pogonion.
Y axis (Growth axis): The line from Sella & Gnathion. (S-Gn)
The growth axis is measured as an acute angle formed by the intersection of a line from Sella turcica to Gnathion with the Frankfort horizontal plane.



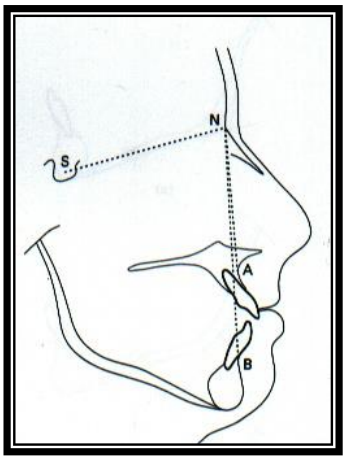


Note: The vertical reference lines used mainly for incisors position assessment.

Cephalometric Angles

Assessment of antero-posterior skeletal pattern

ANB Angle



In order to be able to compare the position of the maxilla and mandible, it is necessary to have a fixed points or planes. the skeletal pattern is often determined cephalometrically by comparing the relationship of the maxilla and mandible with the cranial base by means of angles SNA and SNB.

SNA: represents the relative anteroposterior position of the maxilla to the base of the skull

SNB: represents the relative position of the mandible to the base of the skull

ANB: SNA, SNB difference, represents the relative anteroposterior jaw relations of the maxilla to the mandible

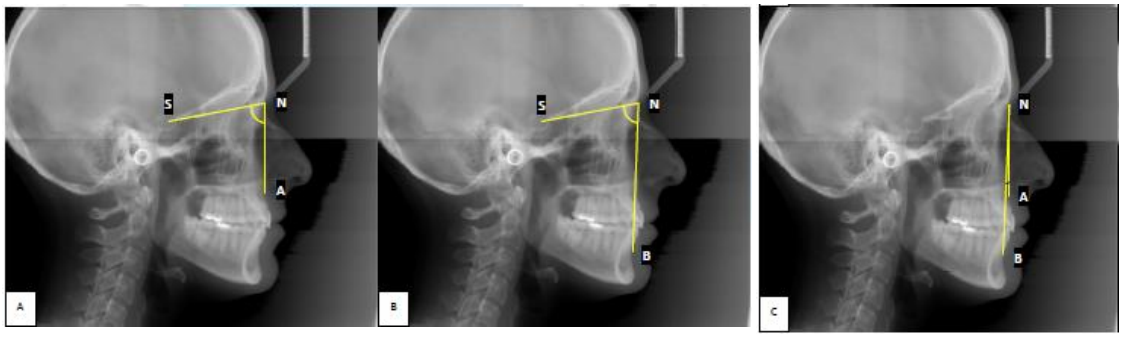
To enable comparison of the position of the maxilla and mandible, it is necessary to have a fixed point or plane. The skeletal pattern is often determined cephalometrically by comparing the relationship of the maxilla and mandible with the cranial base by means of angles SNA and SNB. The difference between these two measurements angle ANB is classified broadly as follows:

Class I ANB (2˚ - 4˚) ……. 2º ≤ ANB ≥ 4º Class I

Class II ANB more than 4˚……. ANB > 4º Class II

Class III ANB less than 2˚…… ANB < 2º Class III

The above angles measure the sagittal “anteroposterior.” relation of jaws to each other and to the base of the skull

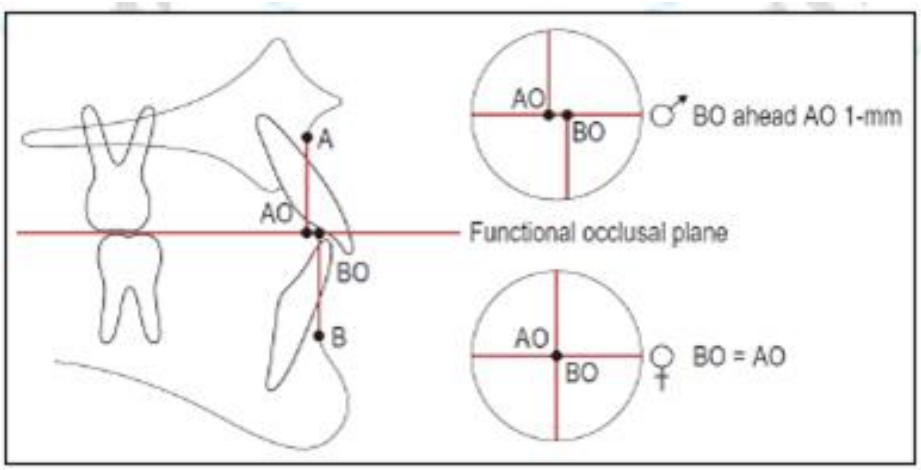


However, this approach assumes (incorrectly in some cases) that the cranial base as indicated by the line SN, is a reliable basis for comparison and that points A and B are indicative of maxillary and mandibular basal bone. Variations in the positions of Nasion can also affect angles SNA and SNB and hence the difference ANB. If SNA is increased or reduced from the average value this could be due to either a discrepancy in the position of the maxilla (as indicated by point A) or Nasion, and correction of ANB angle may be required.

Wits' Analysis

This analysis compares the relationship of the maxilla and mandible with the occlusal plane. There are several definitions of the occlusal plane, but for the purposes of the Wits analysis it is taken to be a line drawn between the cusp tips of the molars and premolars (or deciduous molars), known as the functional occlusal plane (FOP). Perpendicular lines from both point A and point B are drawn to the FOP to give points AO and BO. The distance between AO and BO is then measured. The average values are −1 mm for males and 0 mm for females.

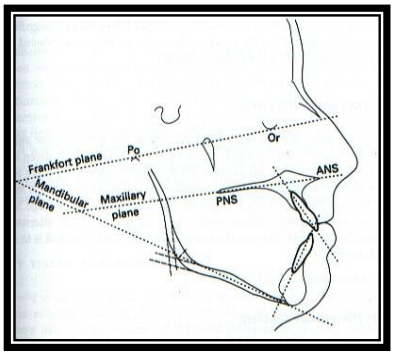
The main drawback to the Wits analysis is that the FOP is not easy to locate, which affects the accuracy and reproducibility of the Wits analysis. A slight difference in the angulation of the FOP can have a marked effect on the relative positions of AO and BO.



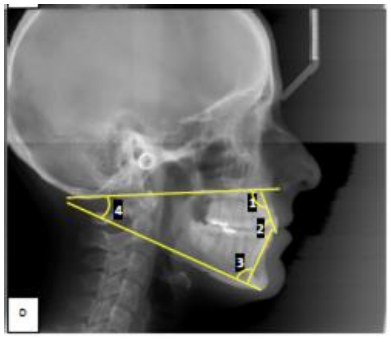
Wits' analysis.

Assessment of vertical skeletal pattern.

There are many different ways of assessing vertical skeletal proportions. The most commonly used include the following: -



1) Frankfort Mandibular Plane Angle {FMPA}: Frankfort mandibular plane angle represents the relative vertical position of the mandible to the Frankfort plane.
The average of this angle is **28º ± 4º.** However, the maxillary plane is easier to locate accurately and therefore the MMPA is preferred.



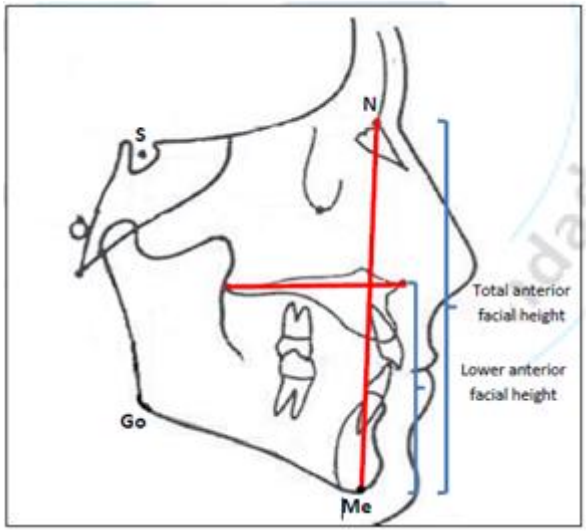
2) Maxillary Mandibular Plane Angle {MMPA}: Max-Man. Angle represents the relative vertical jaw relationship, of the Maxilla to the mandible.
The above two vertical angles measure the vertical "height "of the jaws & if increase means that there is increase facial height and vice versa if decrease.
The average angle between the maxillary plane and the mandibular plane is **27º ± 4º.**

3) SN-Mandibular Plane Angle (SN-MP)
The average of this angle is 32º.

4) Anterior Facial Proportion

This is the ratio of the lower facial height to the total anterior facial height measured perpendicularly from the maxillary plane, calculated as a percentage (Normal value = 55%) :

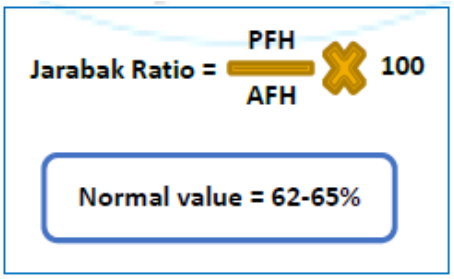
$$\textbf{Anterior Facial Proportion} = \frac{\text{Lower anterior facial height}}{\text{Total anterior facial height}} \times 100$$



Anterior facial proportion.

5) Facial Heights

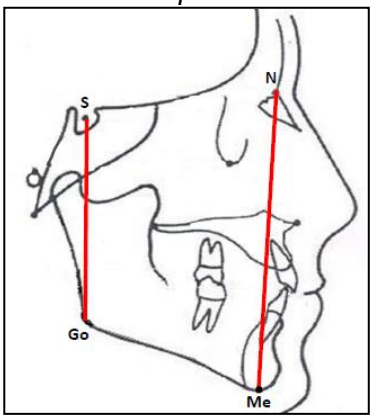
Posterior facial height (S-Go) × 100/anterior facial height (N-Me) = 62-65% (**Jarabak ratio**).



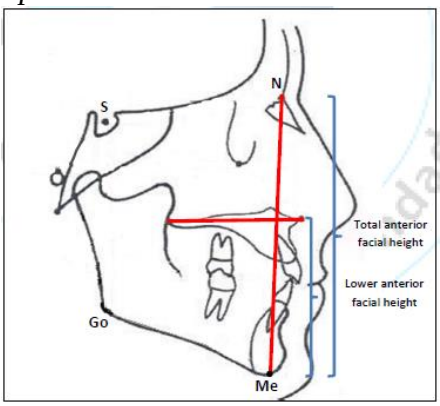
A smaller value means shorter posterior face height (or longer anterior facial height) and vertical growth.

Higher value means greater posterior face height (or shorter anterior facial height) and horizontal growth.

Note: *The horizontal reference lines used for growth pattern assessment.*

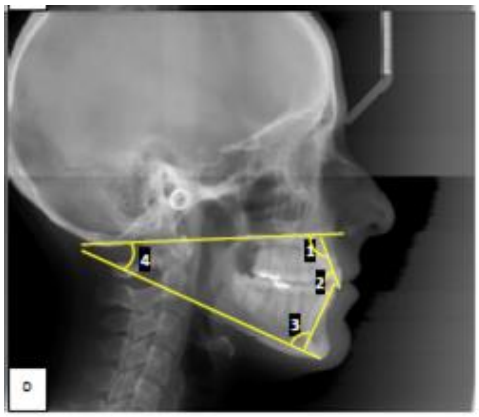


Jarabak ratio



Anterior facial proportion.

Assessment of incisor inclination and position.



- **1/max:** represents the axial inclination of upper incisors to max. plane.

The average value for the angle formed between the upper incisor and the maxillary plane is **109º ± 6º.**

- **1/man:** represents the axial inclination of the lower incisors to the mandibular plane.

The average value for lower incisor to mandibular plane angle is **93º ± 6º** for an individual with an average MMPA 27º.

- **1/1: "** Interincisal Angle " represents the relative axial inclination of upper and lower incisors to each other.

However, there is a relationship between the MMPA and the lower incisor angle: as the MMPA increase, the lower incisors become more retroclined. As the sum of the average MMPA (27°) and the average lower incisor angle (93°) equals 120°, an alternative way of deriving the **'average'** lower incisor angulation for an individual is to subtract the MMPA from 120°: ***Lower incisor angle = 120° – MMPA***.

The inter-incisal angle is established by passing a line through the incisal edge and the apex of the root of the maxillary and mandibular central incisors.

The last three angles measure the relative position & inclination of incisors to their opposing jaws if 1/max increase then there is proclination of upper incisors and e.g., if 1/man decrease then there is a retroclination of lower incisors.

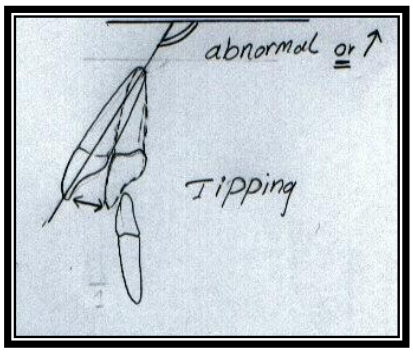
As shown in the figure if any angle lies within normal range, then the condition is normal but if decrease or increase then we can say that there is abnormality.

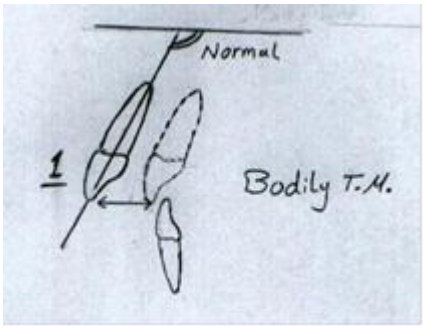
For instance, if FM increase then there is increase in lower facial height commonly associated with Cl III malocclusion & cases of skeletal open bite, but if FM angle is decreased its associated with short faces especially in cases of Cl II div. 2 malocclusion or with patient that exhibit a deep complete overbite.

When we gather all the information taken from the history, clinical examinations "including skeletal, soft tissue and dental factors", radiographic examinations the cephalometrics findings in addition to the observations taken from study models and combine it with the chief complain of the patient, we may proceed in our treatment plan which

should be in harmony with our aims in orthodontics, as much as possible i.e. we should not treat patient CC alone.

For example : we may have tow cases of Cl II div1 malocclusion , both of them are with equal amount of over jet , same canine inclination ,same age & sex, same overbite…etc., but there is a difference in incisors inclination , the 1st is with normal 1 to max plane & 2nd with increase 1/max plane So, the treatment in the 1st case should go with bodily type of teeth movement to educe the increased over jet & the 2nd should go with tipping type of tooth movement both can be performed by fixed appliance & the 2nd could be performed by a removable appliance also. This example is an absolute one. We take inconsideration only the increased OJ for a studying purpose. But the real story is something different.





Over jet reduction by tipping movement unacceptable (note upper incisor root through labial plate). So far, we orthodontists regard an orthodontic diagnosis is one of the most difficult and hard to reach it!!!!!!!

Soft tissue analysis: -

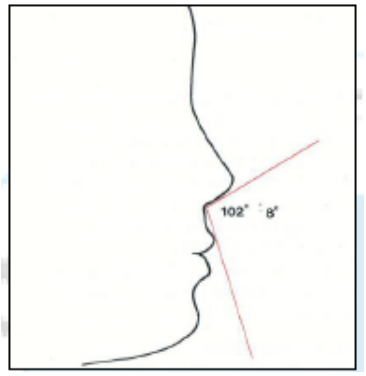
The soft tissue profile can also be seen on lateral skull cephalometric radiograph.

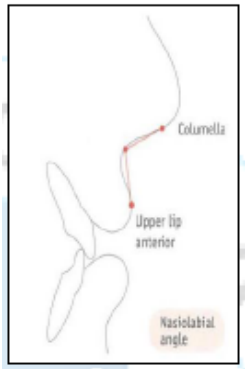
This is particularly important in diagnosis and planning prior to orthognathic surgery. As with other elements of cephalometric analysis, there are large numbers of different analyses of varying complexity.

The more commonly used measurements are:

Nasolabial Angle

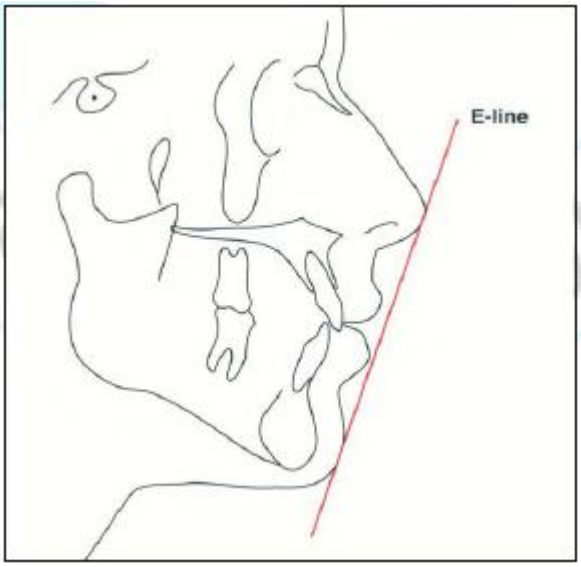
It is formed by two lines, a columella tangent and an upper lip tangent. Normal range for this angle is 102° ± 8°. This angle should be studied prior to orthodontic extraction and retraction – if it alters to unesthetic value, extraction and retraction should be avoided.





Rickett's E-Line

The E-line is drawn from the soft tissue pogonion to the tip of the nose. Normally the upper lip is about 4 mm behind this reference line while the lower lip lies about 2 mm behind it.



Rickett's E-plane.

Steiner's S-Line

The S-line is drawn from soft tissue pogonion to the midpoint of S-shaped curve between Subnasale and nasal tip. The lips should touch the reference line. Lips lying behind this reference line are too flat, while those lying anterior to it are too prominent.

Steiner's S-plane.

Note: *The lip position (upper or lower) could be varied according to the age, sex and ethnic group*

Assessing Growth and Treatment Changes

The advantage of standardizing lateral cephalometric radiograph is that it is then possible to compare radiographs either of groups of patients for research purposes or of the same patient over time to evaluate growth and treatment changes. In some cases, it may be helpful to monitor growth of a patient over time before deciding upon a treatment plan, particularly if unfavorable growth would result in a malocclusion that could not be treated by orthodontics alone. To enable accurate comparison of radiographs, it is

necessary to have a fixed point or reference line, which does not change with time or growth. This poses a dilemma, as there are no natural fixed points or planes within the face and skull. This should be borne in mind when interpreting the differences seen on superimposed cephalometric radiographs.

Cranial Base

The SN line is taken in Cephalometrics as approximating to the cranial base. However, growth does occur at Nasion, and therefore superimpositions on this line for the purpose of evaluating changes over time should be based at Sella. Unfortunately, growth at Nasion does not always conveniently occur along the SN line; if Nasion moves upwards or downwards with growth, this will introduce a rotational error in comparisons of tracings superimposed on SN. It is more accurate to use the *outline of the cranial base* as little changes occur in the anterior cranial base after 7 years of age. However, a clear radiograph and a good knowledge of anatomy are required to do this reliably.

The Maxilla

Growth of the maxilla occurs on all surfaces by periosteal remodeling. For the purpose of interpretation of growth and/or treatment changes the least affected surface is the anterior contour of the *zygomatic process*. This is the preferred structure for superimposition, however, the *maxillary plane* registered at the PNS is commonly used as it is easier to identify.

The Mandible

The mandibular plane is sometimes used for superimposition of the mandible; however, this can be highly erroneous due to significant remodeling in the lower border and angle of mandible. The landmarks that change least with growth and are therefore preferred for superimposition are as follows (in order of usefulness):

- The innermost surface of the cortical bone of inferior border of the symphysis.
- The anterior contour of the chin.
- The outline of the inferior dental canal.
- The crypt of the developing third permanent molars from the time of mineralization of the crown until root formation begins.
- The tip of the chin.

Key Point

Cephalometric assessment is an adjunct to clinical assessment and findings from cephalometric analysis should be interpreted with consideration of clinical findings. The aim of orthodontic treatment is to improve the patient's appearance, not to move them nearer to a cephalometric norm.